ORIGIN OF AMERICAN COLD WAVES.

By R. F. STUPART, Director Meteorological Service, Canada, dated Toronto, May 17, 1904.

As yet I am unable to add much to what I said in my letter of February 9. Without doubt, however, the question is so intimately connected with the movement of high and low areas, that I am having some maps printed, taking in all the northern territories almost to the Arctic Sea, as it appears to me this is the best way of arriving at results. With the barometer reading at Dawson, York Factory, Fort Chipewyan, Moose Factory, and Norway House, we shall be able to extend our isobars and get a better idea of the formation and subsequent movement of highs and the accompanying cold waves. From the further work I have done I think it is apparent that in some seasons pronounced cold waves developing in Yukon, or in the far North, never reach either Alberta or Manitoba. In other months, while there is nothing abnormal in the far Northwest, a cold wave may develop just north of Manitoba and Ontario, and the temperature in these provinces fall almost as low as near the Arctic Circle. I am satisfied, however, that it is true in a general way that a cold wave may be expected in Manitoba about five days after it sets in over the Klondike.

INCREASED FLOW OF SPRING WATER IN THE AUTUMN[1].

By G. A. LOVELAND, Section Director, dated Lincoln, Neb., May 28, 1904.

Many of the inhabitants of north-central and northwestern Nebraska have become convinced by casual observation that there is an increased flow of water from natural springs during the fall and winter months, and that at the same time water in the marshes and small lakes of the region increases in depth. So far as the writer is aware, no measurements have been made by which the times and amounts of fluctuation can be determined with any exactness. While lack of such measurements limits the discussion, some facts affecting water supply in this region can be presented. These facts relate to: 1. Geological structure. 2. Precipitation and temperature. 3. Evaporation. 4. Run-off in streams.

1. *Geological structure.*—The surface soil in Nebraska west of the ninety-eighth meridian and north of the Platte River is sandy in formation. In fact, about 24,000 square miles in the central portion of the region (65 per cent of the entire district) are occupied by wind-blown sands, constituting the great sand-hill district. North and west of the sand hills are large areas of Arikaree and Ogalalla formation, both with a large proportion of sand in their composition. Outcropping near the Platte River, and underlying most of the western third of the territory under consideration, is the Brule clay. Beneath all these, and underlying all of Nebraska west of the ninety-eighth meridian, and extending considerably east of that meridian in some localities, is the Pierre clay. Its surface outcrops are in the lower portion of the Niobrara Valley, the Republican Valley, and the extreme northwestern portion of the State. It is a mass of nearly impervious Cretaceous clay and shale 1000 to 2000 feet thick in the central and western portions of Nebraska.

At some distance beneath this Pierre clay is the water-bearing Dakota sandstone formation, which outcrops in the eastern portion of Nebraska and carries the great artesian water supplies which are so extensively developed in South Dakota and northeastern Nebraska. This formation also furnishes water for springs and wells in southeastern Nebraska; but it does not affect the surface water supply in the northwestern portion of the State, for the Dakota sandstone is separated from the sandy surface soil by the thick and nearly impervious layer of Pierre clay.

The water supply for the springs and lakes of this district is a question of precipitation upon, evaporation from, and percolation through a sandy soil, varying from 100 to 400 feet in thickness.

2. *Precipitation and temperature.*—Nearly one-half the annual precipitation occurs during the three months of May, June, and July, while only about one-eighth of the annual amount falls during the four months of November, December, January, and February. The following table contains the monthly and annual average precipitation, in inches, for the district, computed from the records of the past twenty-eight years:

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
0.52	0.65	1.05	2.18	3.12	3.37	3.06	2.23	1.53	1.17	0.48	0.60	19.96

The following table contains the monthly and annual average temperatures for the district, computed from the records of the past eighteen years:

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
21.9	22.8	32.8	48.3	58.4	68.1	73.8	71.9	62.5	49.9	34.6	27.2	47.8

The water sinks readily into the sandy, permeable soil until it strikes the nearly impermeable clay layer beneath; then, as it can go no farther downward, it saturates the soil, raising the surface of the saturated zone (which is called the water table) toward the surface until it is high enough for the water to flow off laterally through the soil to a ravine or low spot. Here the water comes to the surface and either evaporates or passes along the ravines to the rivers that drain the district. These rivers carry the water across the eastern or lower outcropping areas of the Pierre clay.

3. *Evaporation.*—The evaporation is very large in summer from the surface of both water and soil. The latter, because of its sandy nature, becomes very hot under the rays of the summer sun. A relatively small proportion of the rainfall is absorbed by the vegetation. No satisfactory measurements of evaporation are available, but it is believed the following table[2] fairly presents the evaporation from a free water surface, in inches, and its variation throughout the year:

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
1.92	2.73	3.20	4.83	5.06	5.33	6.68	5.81	4.80	3.36	1.86	2.66	48.24

4. *Run-off in streams.*—That the volume of water in rivers draining this region is remarkably uniform, is shown by the daily gagings. The surface run-off after heavy rains is very much less than from most soils, and the large body of saturated sand furnishes water to prevent a large decrease during dry periods.

The run-off from three rivers of the region has been measured for a period of from two to five years; the Niobrara at Valentine, and the North Loup and Middle Loup at St. Paul. The daily mean flow in cubic feet per second is given in the following table. Unfortunately there were no measurements in the winter months for the longer records:

[1] The present paper relates to the subject of the flow of spring water after the first killing frost mentioned in the Monthly Weather Review for January, 1904, p. 23.

[2] Computed from the data published in Climate and Crop Report for Nebraska, November, 1896.